EXPLOITATION OF WASTE HYDROLYSATE FROM POULTRY INDUSTRY FOR GROWTH OF MICROORGANISMS WITH POTENTIAL OF CARBONATE PRECIPITATION

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Introduction

The continuous rise in atmospheric carbon dioxide levels, which is a primary driver of climate change according to the Paris Climate Agreement (Kelemen et al., 2015). Currently, it is estimated that approximately 40 GtCO_2/year of cumulative carbon dioxide (CO_2) is being released into the atmosphere (IPCC Report 2018, https://www.ipcc.ch/sr15/). To mitigate this carbon footprint, one approach is to recycle and repurpose waste from various industries. The global annual production of solid waste is estimated to be around 7-9 billion tonnes, with an increasing trend each year. Within the European Union (EU), construction and demolition waste alone accounts for over a third of the total waste generated. Microbiological calcite precipitation (MICP) technology, also known as bio-concrete (Song et al., 2022), offers a viable solution to recycle waste and reduce the carbon footprint and energy consumption. This innovative technology employs microorganisms to create a composite material.

MICP has immense potential for recycling solid waste from diverse industries such as construction, mining, metallurgy, and manufacturing. It can significantly diminish the carbon footprint, as the concrete industry is responsible for up to 8% of total anthropogenic CO_2 emissions. However, the application of MICP is predominantly confined to laboratory conditions due to the high costs associated with commercial nutrient media required for bacterial growth. To address this issue, one cost-reducing strategy involves replacing the conventional nutrient media with waste hydrolysates rich in peptides and nutrients, such as those derived from the poultry industry. In this study, we explored the use of feather hydrolysate as a substitute cultivation medium for the ureolytic bacterium *Sporosarcina pasteurii* DSM 33. This bacterium acts a crucial role in the formation of calcium carbonate crystals through MICP. By employing feather hydrolysate, we aimed to investigate the potential for calcium carbonate crystal formation.

Methods and Results

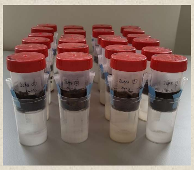
Preparation of WCF suspension

Waste concrete fines (WCF)

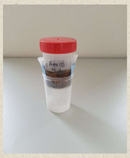
WCF mixed
with saline

S. pasteurii DSM 33

WCF sample



MICP process in composite biocementation – classical approach (poster ID 258)



adding of biocementation solution (**source of nutrients**, urea and Ca^{2+}) each 48-72 hours for 30 days

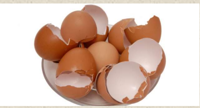
30 days of drying

Alternative sources of nutrients in biocementation solution: waste feather hydrolysate

sources of nutrients

poultry industry

feather hydrolysates



sources of Ca^{2+}

Poultry consumption:
2010 ~ 52 million tons
2020 ~ 120 million tons

composition: over 90% protein, majority is beta-keratine, insoluble structural protein
Fat 2%

The annual feather production
Czech Republic - 10-12 thousand of tonnes
Worldwide - 6-8 millions of tonnes

Raw feather hydrolysis

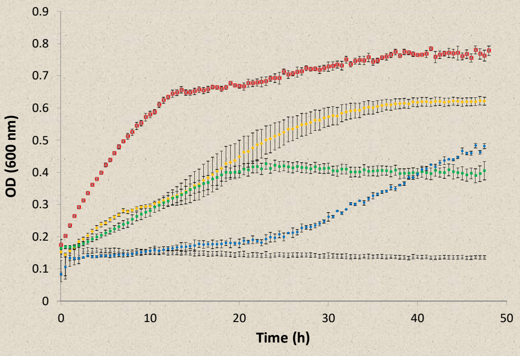
- Whole cell microbial hydrolysis
  - using strains with keratinolytic activities
- Enzymatic hydrolysis
  - using semipurified keratinase
- Chemical hydrolysis
  - using mild alkali condition
  - 0.6% of NaOH, 70 °C

Type of hydrolysis	Amino acids [g/L]	Peptides [g/L]
***Pseudomonas* sp. P5 (A)**	0.30 ± 0.03	6.2 ± 0.2
***Pseudomonas* sp. P5 (B)**	0.27 ± 0.07	4.6 ± 0.1
Keratinase (A)	**1.05 ± 0.15**	3.2 ± 0.2
Keratinase (B)	**1.09 ± 0.08**	3.3 ± 0.2
Alkali cond. (A)	0.33 ± 0.05	**17.2 ± 2.6**
Alkali cond. (B)	0.38 ± 0.02	**14.3 ± 0.1**

A - The initial amount of wet raw feather material was 90 g/L (31.9 g of dry feather /L).
B - The initial amount of wet raw feather material was 70 g/L (24.9 g of dry feather g/L).

Hydrolysates – source of nutrients for bacterial growth

Hydrolysates – sterilized, neutralized with HCl (alkali hydrolysis)
Tested microorganism – *Escherichia coli,* measured for 48 h on Bioscreen system



Hydrolyzates obtained by:
- 🟨 Alkali,
- 🟩 Enzymatic,
- 🟦 Microbial
- ■ Luria-Bertani broth
- ▨ Control - unhydrolyzed feather

Application of hydrolysates:
- Organic fertilizers
- In cosmetics
- **Peptone substituent in culture media**

Conclusions

- Animal by-products - high variability of reusing – feather hydrolysates source of nutrients for bacterial growth (Stiborova et al., 2016); other sources of Ca^{2+} - egg shells
- Waste feathers
  - possible use as a nutrients in MICP proces utilizing *Sporosarcina pasteurii* DSM 33
- Feather hydrolysates as a source of nutrients fulfil the concept of recycling and circular economy

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